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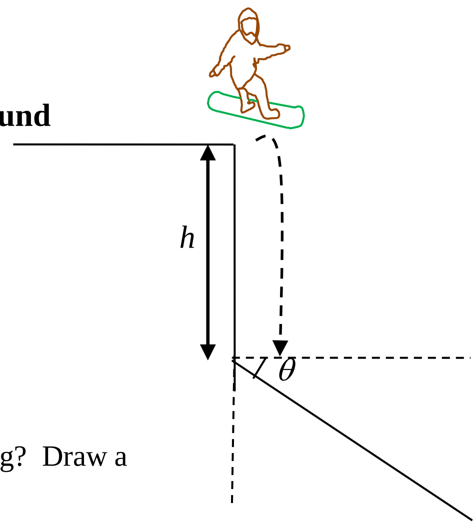

Problem – snowboarder- vertical cliff and sloping ground

Consider a snowboarder of mass m who drops off a vertical cliff height h of 2.0 m onto hard sloping snow. As the snowboarder lands on the sloping snow they bend their knees dropping their center of mass a vertical amount b of 0.25 m. Take $\theta = 45^o$.

a) What are the important forces exerted on the rider on landing? Draw a free body diagram of the person on landing.

b) Estimate the magnitude of the average acceleration of the person on landing and the average normal force F_N exerted on the snowboarder.

c) Draw a graph of F_N versus time during the landing. Show the assumed (average) form in this problem and show what you believe to be the true form.

The paper takes this one step further by allowing the snowboarder to have a horizontal velocity before they drop off the cliff.

[solution on next page]

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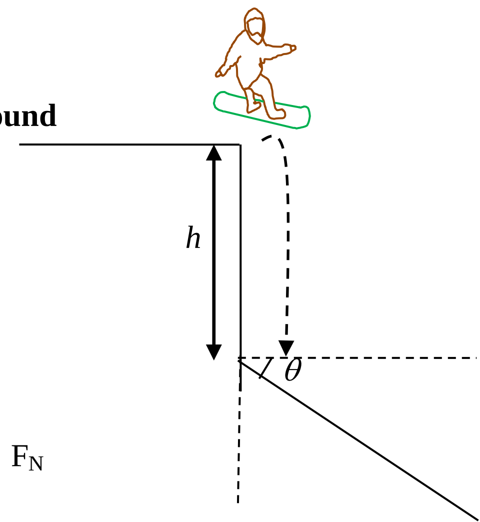

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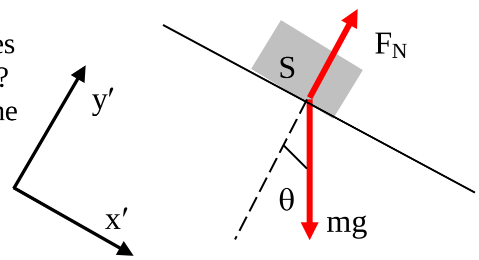


b) Estimate the magnitude of the average acceleration of the person on landing and the average normal force F_N exerted on the snowboarder.

The final velocity along *y*' zero. Therefore the acceleration *a*′ along *y*′ is

$$a' = \frac{\left(v_{fy}'^2 - v_y'^2\right)}{2(-b)\cos\theta} = \frac{v_y'^2}{2b\cos\theta}$$

Application of Newton's second law along y′ gives $F_N - mg\cos\theta = ma'$ which yields

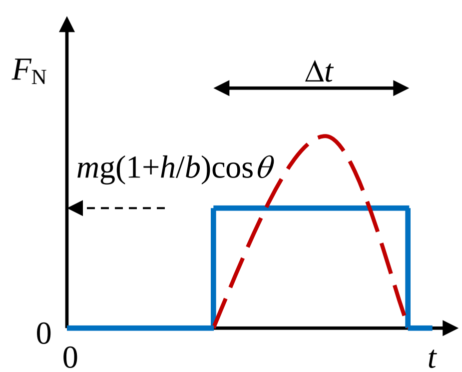
$$F_N = m\left(a' + g\cos\theta\right) = m\left(\frac{v_y'^2}{2b\cos\theta} + g\cos\theta\right)$$

Substituting for v_y' , $v_y' = (\sqrt{2gh})\cos\theta$, gives:

$$F_N = mg\left(1 + \frac{h}{b}\right)\cos\theta \;= 6.4\text{ mg}$$

which gives the value of the normal force on landing. Notice that if $\theta = 0$ (landing on a flat surface) Eq. 3 is obtained. The presence of the slope reduces the normal force felt by the snowboarder on landing by a factor of $\cos\theta$.

c) Draw a graph of F_N versus time during the landing. Show the assumed (average) form in this problem and show what you believe to be the true form.



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